The unpredictable safety impact of COVID19

Toni Flint

Author biography

Toni is a Senior Inspector of air accidents at the UK Air Accidents Investigation Branch. At the AAIB she is responsible for investigating the human factors aspects of accidents and serious incidents and developing the AAIB's capability in human factors investigation. She joined the AAIB in 2018. Prior to that she worked for 16 years as a human factors specialist in road and rail transport applications.

Background

In the UK, between March 2020 and June 2021 there was a confusing procession of restrictions imposed and restrictions lifted in response to the COVID19 global pandemic. Everyone in the UK was told to stay at home from 23 March 2020 and this began to be lifted from 10 May 2020. Summer 2020 was the year of the 'staycation' with relative freedom within the UK, but international travel was not possible for most. From September 2020 restrictions started to be reintroduced. Rules and timelines differed between the UK nations and within different local regions. There were further local and national lockdowns in winter 2020/2021 including the whole of England from 4 January 2021 into the spring. The last of the restrictions in England were removed on 21 June 2021 and, so far, in September 2022, no further restrictions have needed to be imposed.

Internationally the situation around air travel depended on a complex interaction of state policies about who could travel where and for what purpose. In general, passenger air travel to and from the UK was severely reduced throughout the pandemic. There were also long time periods when general aviation was restricted and reduced. However, other types of flying such as emergency services and cargo transport continued or increased.

The potential safety impact of the pandemic did not take our industry by surprise. Safety professionals, managers and front-line staff in many organisations did their best to anticipate and mitigate the likely effects. The most mentioned hazards seemed to be 'rusty aircraft and rusty pilots'; the degradation of aircraft condition from not being used and the reduction in pilot skill from lack of recent practice. Deeper research into material published by various regulators showed that the analysis had, of course, been much more comprehensive.

In June 2020, just as the world started to emerge from the first wave of the pandemic, EASA published a review of safety issues arising from the stopping and restarting of aviation because of the pandemic (7). It was based on surveying and meeting with multiple aviation industry stakeholders. The review identified hazards arising from the pandemic in six main areas: management systems; human performance; training, checking and recency; outdated information; infrastructure and equipment and financial impacts. The list included everything you would expect from the risk of spreading COVID19 internationally via air travel to the threat to aircraft from increased wildlife at aerodromes. Documents and guidance on safety vs. the pandemic were issued by our UK regulator, the Civil Aviation Authority (5), ICAO (10) and many other organisations around the world.

The EASA review highlighted a 'catch-all' topic around the challenge of restarting a complex system:

'*The aviation system is highly interconnected, sophisticated and merges people and technology, meaning the consequences of shut-down and restart are not completely predictable.*'

This paper describes three cases, investigated by the AAIB in the UK, where the COVID19 pandemic combined with other factors to degrade safety in an unpredictable way.

G-CGTC, 12 November 2020, Britten Normal Islander, double engine flame out near City of Derry Airport in Northern Ireland (1)

G-CGTC is a Britten Norman BN-2T-4S Islander, based on the Britten Norman Islander but with a stretched fuselage, enlarged wing and modified nose structure. It is fitted with two Rolls Royce M250-B17F/1 turboprop engines.

On 12 November 2020 at 2054, G-CGTC suffered flame out of both engines at around 7000 ft close to City of Derry Airport in Northern Ireland. The pilot was initially startled but with the assistance of one of the passengers, recovered and was able to start his engine failure drills. Descending at a peak rate of approximately 3,300 ft/min, he tried to reach the nearby airport. Fortunately, at an altitude of 2,100 ft amsl, one of the engines was restarted 74 seconds after it had failed. Around 7 minutes later at 800 ft amsl, the second engine was also restarted. The pilot felt uncertain about the reliability of the engines, so decided to continue with landing at the closed and unlit City of Derry Airport. The runway was barely visible in reflected cultural lighting, but the aircraft was landed successfully with no damage or injuries.

There was a cold front in the area with thick layers of cloud from around 1,500 ft amsl up to 16,000 ft amsl. The 0°C Isotherm was around 8,500 ft. At the time of the engine failures, the aircraft had been flying at around 7000 ft with an outside air temperature of 0^{o}C for about 10 minutes. The conditions would have made the aircraft susceptible to airframe and engine intake icing. Analysis of the flight data showed decreasing fuel flow in both engines eventually reducing to zero before the engines flamed out. The aircraft was equipped for flight in known icing conditions with a powerplant anti-ice system and a pneumatic de-icing system for the wing and tail leading edges. Having ruled out malfunctions and fuel causes, the investigation found it was likely that the pilot did not turn on the engine anti-icing system before entering engine icing conditions.

The pilot was nearing the age where he would no longer be permitted to fly in single pilot operations but he hoped to continue employment with the operator in some capacity. At the time of the incident, he was very close to his flying retirement age but still did not know what role, if any, he would be offered. He stated during interview that uncertainty over his future, and other personal stressors, had contributed to him feeling worried and had caused his sleep pattern to be badly disrupted. He did not consider this bad enough to affect his flying performance. The pilot also had limited recent experience flying in icing conditions. The investigation could not determine for certain whether sleep loss and stress did contribute to the pilot forgetting engine anti-ice but the relationships between stress, disrupted sleep and impaired human performance are well established and are acknowledged hazards in aviation.

At the time of the incident, the UK was operating under severe social restrictions due to the COVID19 pandemic. This affected the situation in two ways. First, staff shortages and pressures created by public health restrictions had hampered the resolution of the pilot's employment status so that by the time of the incident he had been living with stressful uncertainty for about a year. Second, while flying was permitted to continue, the operator had introduced procedures to keep staff apart as much as possible. This meant that the pilot was working largely in isolation, and no one was able to recognise his struggles or offer informal support.

The operator took safety action to improve training by introducing a winter programme, briefing and checklist use for flight in icing conditions. They also increased communications to pilots relating to mental wellbeing and provided access to a specific aviation-focused peer support programme.

G-HYZA, 29 April 2021, Malibu Mirage with an experimental modification, power loss and forced landing, near Cranfield Airport in England (3)

G-HYZA was a modified Piper PA-46-350P, Malibu Mirage. It was an experimental aircraft designed to demonstrate the potential for an aircraft to be powered by a hydrogen fuel cell. The original piston engine had been replaced with two Yokeless and Segmented Armature (YASA) electric motors which were powered by two sources of electricity, a high voltage battery and a hydrogen fuel cell. The aircraft could be operated using both sources together or either individually.

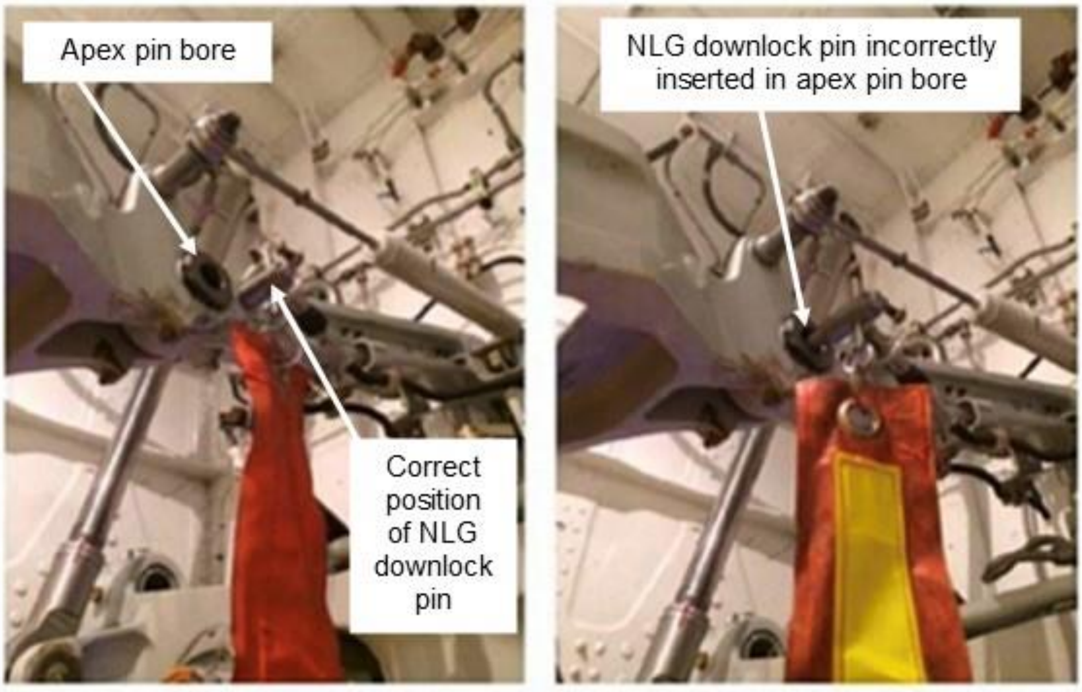
On 29 April 2021, G-HYZA was on a test flight with a pilot and an observer on board. The objective of the flight was to demonstrate flight on the fuel cell alone for three or more circuits of Cranfield airport. The takeoff was conducted using both power sources. When the pilot selected the HV battery off to continue on the fuel cell alone, all power to the motors was lost. The aircraft was at the runway threshold at approximately 940 ft agl when this occurred, the pilot and observer tried to restore the power supply but were unsuccessful and by the time they realised they must commit to a forced landing they were at 320 ft agl and had travelled the length of the runway. The aircraft landed in a field and was significantly damaged when it struck a hedge and came to rest in a ditch. The pilot and observer were not injured.

The experimental test flying was conducted under relatively new UK regulations: Civil Aviation Publication (CAP) 1220, '*Operation of experimental aircraft under E Conditions*' (4). First published in November 2015, E Conditions enable a UK registered, commercially or amateur built, non-EASA aircraft with a Maximum Take off Mass (MTOM) of 2,000 kg or below to test a concept in the air without having to comply with the more stringent requirements of other regulations as long as no risk is posed to uninvolved third parties. Safety of such flying is required to be guaranteed by a 'competent person' who is a chartered engineer and member of the UK's Royal Aeronautical Society. G-HYZA's competent person worked for a consultancy organisation who were contracted to the operator.

The investigation explored the technical, operational and organisational causes of the accident, of which there were many. One aspect was ad hoc decision making by the flight crew who had decided to change the test parameters and the location of the switch between power sources without discussion with the competent person. It transpired that the competent person was quite distant from the project with limited involvement on a day-to-day basis. One reason for this was that, while the experimental project team continued to work physically together, the competent person was still working at home due to the COVID19 pandemic. Total power loss was foreseen as a possibility for this experimental aircraft and perhaps the accident would still have occurred even with closer oversight from the competent person. However, working at home was a factor that affected the competent person's ability to fulfil his important safety responsibilities because he had to try and do so using only remote communication. The operator took safety action to improve their approach to flight testing and to strengthen and formalise their safety management system. The AAIB made five safety recommendations to the UK CAA around the scope and content of E Conditions.

G-ZBJB, 18 June 2021, Boeing 787-8, Inadvertent retraction of the nose landing gear, Heathrow airport in England (2)

G-ZBJB is a Boeing 787 operated by a major commercial air transport operator in the UK. In the early morning on 18 June 2021, it was being prepared for a cargo flight by a team of maintenance engineers and the flight crew. The engineers were engaged in maintenance activity to clear three status messages associated with a defect for a nose landing gear door-closed solenoid valve. It required the cockpit landing gear lever to be cycled. The lead engineer instructed two of the mechanics to fit the landing gear locking pins that would prevent the landing gear retracting during this process. The pin for the nose landing gear was fitted into the wrong hole so that when the landing gear lever was operated, it did not lock the nose landing gear. The nose landing gear retracted causing the nose of the aircraft to collapse to the ground. A loader was injured when struck by a descending cargo door and there was millions of pounds worth of damage to the aircraft. The front left passenger door was ripped off by the passenger stairway as the aircraft collapsed and there was the potential for serious or fatal injury had people been boarding or under the aircraft at the time.



The AAIB published a special bulletin within a month to highlight the potential for incorrect fitment of the pin. A detailed investigation followed that considered the performance of the maintenance team, the post-accident emergency response, and organisational factors within the maintenance organisation. The design of the nose landing gear on the Boeing 787 created a high probability for error because there were two similarly sized holes close together. Fitment of the pin in the wrong one felt, looked, and sounded similar to fitment in the correct one. The manufacturer and the regulator had been aware of this hazard since early 2018 because of other events. A service bulletin and airworthiness directive had been issued for a modification that would blank the incorrect hole. The airworthiness directive had a three-year compliance period until 16 January 2023. The operator intended make the required modifications but, as was permitted by the long compliance period, had chosen to postpone it because of the operational and financial pressures created by the COVID19 pandemic.

The operator has now made the modification to all their 787 fleet. AAIB made two recommendations to the manufacturer and regulator to review the processes used to determine compliance periods for service bulletins and airworthiness directives.

Discussion

The three cases described above are practical examples of how multiple causes, including changes due to the pandemic, combined in an unexpected way to produce an unpredictable outcome. In each case, the COVID 19 pandemic was an additional pressure that robbed individuals and organisations of some of their capacity or resources, leaving them vulnerable to the effects of other hazards that they may otherwise have been able to adapt to and overcome. In each of the three cases there were procedures already in place that may have reduced the chance of the incidents if they were followed. It is an accepted feature of human performance that people adapt to meet the demands of a complex and dynamic work environment and that they assess risks and make trade-offs (11). The net result being that not all procedures are followed perfectly all the time. This leaves a question of how much safety benefit there can be from further development, training, reiteration or enforcement of procedures if these aspects are already strong. However, there will always be a benefit to continued focus on 'traditional' risk mitigation using procedural control.

As the pandemic progressed and evolved, safety professionals continued producing guidance to help operators manage the safety impact. In April 2021, the EASA published an updated version of their review (8). It identified some additional hazards and included references to other safety guidance on specific topics. The 'catch all' hazard about the challenge of restarting a complex system was updated to reflect that the 'gradual recovery' or intermediate situation was part of the hazard. The new version also highlighted that the effects were unpredictable.

The EASA's review pointed to guidance on resilience as the potential solution to the unpredictable safety consequences of the pandemic. The UK CAA also published guidance for operators in May 2021 promoting 'operational resilience' to minimise the safety impact of the pandemic (6). Though this was defined as '*the ability to return safely to pre-COVID levels of aviation activity.*' Therefore, it is unclear whether the two regulators had the same intention.

In the safety and human factors literature, resilience has been variously defined. One recent definition was '*The system can adjust its functioning prior to, during, or following changes and disturbances, and thereby sustain required operations under both expected and unexpected conditions.*' Resilient organisations are considered to be characterised by four capabilities: responding, monitoring, anticipating and learning (9).

Some of the safety actions taken aimed to improve procedural control, for example, additional training or briefing. Some of the safety actions were intended to improve organisational or personal resilience, for example, G-HYZA's operator enhanced their safety management system and G-CGTC's operator improved resources to support pilot wellbeing. The recommendations AAIB made in G-ZBJB are linked to resilience because they intend to improve how Boeing and the Federal Aviation Administration use statistics to learn from past events and anticipate human error when considering the compliance times for service bulletins and airworthiness directives.

The safety investigation authorities' (SIA) role is to investigate the circumstances and causes of an accident or serious incident and to promote action to prevent reoccurrence. This is usually linked to particular events and SIAs help to prevent the same things from happening again by making specific, measurable, achievable recommendations that are justified by the evidence. As shown in these three examples, accidents may emerge from a complex, unpredictable, combination of factors. Specific actions may not address the complex interactions. Specific actions for every cause or contributory factor for every event has the potential to become an enormous, unachievable 'to do' list for managers and front-line employees. Therefore, there is a role for safety improvements or recommendations designed more generally to improve the resilience of the aviation system. The COVID19 pandemic was a crisis that sapped resilience from the aviation system by limiting resources and creating barriers between people. Building resilience during a crisis when there are many unknowns and the situation is changing frequently must be next to impossible so it needs to be a focus of our industry recovery as normality resumes and some capacity starts to become available.

References

(1) Air Accidents Investigation Branch (2021), *BN2T-4S Islander (G-CGTC), Dual engine failure, City of Derry Airport, Eglinton, Londonderry, 12 November 2020*, https://assets.publishing.service.gov.uk/media/612f8ea18fa8f50327b49b6f/BN2T-4S_Islander_G-CGTC_10-21.pdf

(2) Air Accidents Investigation Branch (2021), *AAIB Special Bulletin S1/2021 on Boeing 787-8, G-ZBJB Inadvertent nose landing gear retraction during pre-flight maintenance, London Heathrow Airport, 18 June 2021*, https://www.gov.uk/aaib-reports/aaib-special-bulletin-s1-slash-2021-on-boeing-787-8-g-zbjb

(3) Air Accidents Investigation Branch (2022), *Piper PA-46-350P (Modified), G-HYZA Propulsion system failure and forced landing, one mile north of Cranfield Airport, 29 April 2021*, https://www.gov.uk/aaib-reports/aaib-investigation-to-piper-pa-46-350p-modified-g-hyza

(4) Civil Aviation Authority (2019). *CAP1220 Operation of experimental aircraft under E Conditions*. http://publicapps.caa.co.uk/docs/33/CAP1220EConditions_Edition2_Nov2019.pdf

(5) Civil Aviation Authority (2020) *Safety Notice SN-2020/0011 Human Factors Considerations for Organisations During Covid-19 Restart Activities, version 3*. https://publicapps.caa.co.uk/docs/33/SafetyNoice2020011.pdf [Accessed on 22/07/2022]

(6) Civil Aviation Authority (2021) *Safety Notice SN-2021/012, Operational Resilience –Aviation industry recovery post COVID-19.* http://publicapps.caa.co.uk/docs/33/SN2021012Operational%20Resilience%20%E2%80%93%20Aviation%20industry%20recovery%20post.pdf [Accessed on 22/07/2022]

(7) European Union Aviation Safety Agency (2020*). Review of Aviation Safety Issues Arising from the COVID-19 Pandemic*. https://www.easa.europa.eu/downloads/115463/en [Accessed on 22/07/2022]

(8) European Union Aviation Safety Agency (2021*). Review of Aviation Safety Issues Arising from the COVID-19 Pandemic, version 2 – April 2021*. https://www.easa.europa.eu/sites/default/files/dfu/Review%20of%20Aviation%20Safety%20Issues%20From%20COVID-19%20Final%20-%20v2%20-%20April%202021%20Rev1.pdf [Accessed on 22/07/2022]

(9) Ham, D. (2021). Safety-II and Resilience Engineering in a Nutshell: An Introductory Guide to Their Concepts and Methods. *Safety and Health at Work, Volume 12 (1)*, 10-19. https://reader.elsevier.com/reader/sd/pii/S2093791120303619?token=7BC1D1D5C515DDBA3FF1AE4EFFF37E093BA49450895C3E2308E2655EE8A266A779FC5A7752D9B8DD0CCBDB806723F57F&originRegion=eu-west-1&originCreation=20220720131731 [Accessed on 22/07/2022]

(10) International Civil Aviation Organisation. *Managing Risks to Human Performance (HP)*. https://www.icao.int/safety/OPS/OPS-Normal/Pages/Managing-risks.aspx [Accessed on 22/07/2022]

(11) International Civil Aviation Organisation (2021). *Manual on Human Performance (HP) for regulators. First edition, 2021.* https://www.icao.int/safety/OPS/OPS-Section/Documents/Advance-unedited.Doc.10151.alltext.en.pdf [Accessed on 25/07/2022]